VOLKS WOHNUNG

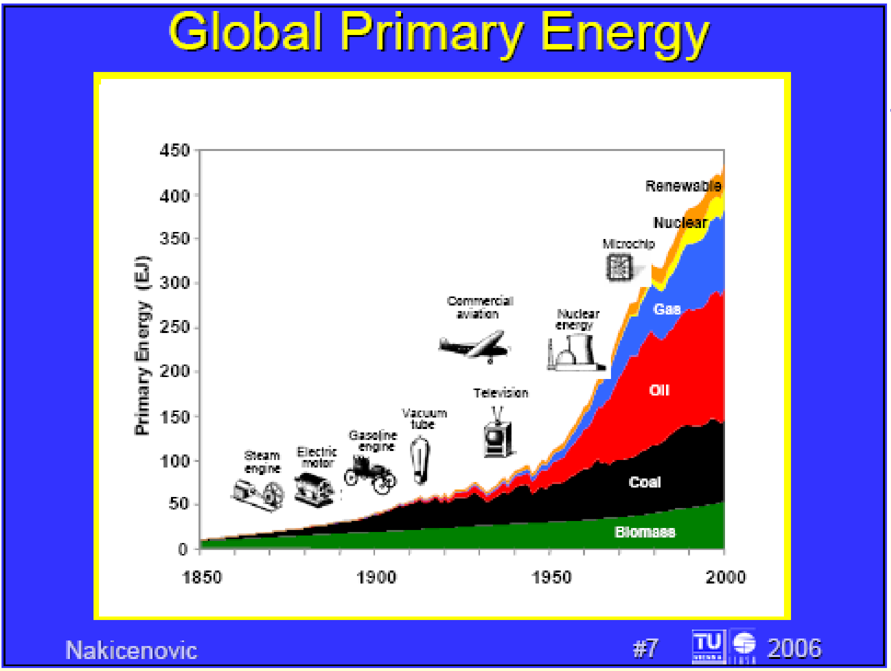
NZE Installations & Deployed Bases

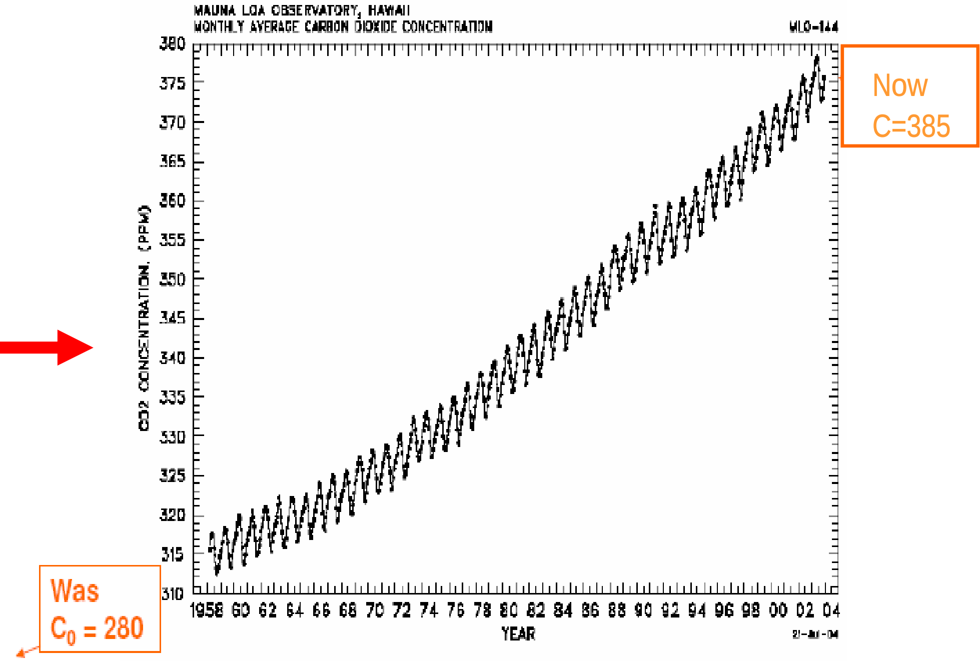
Workshop
US Army Corps of Engineers

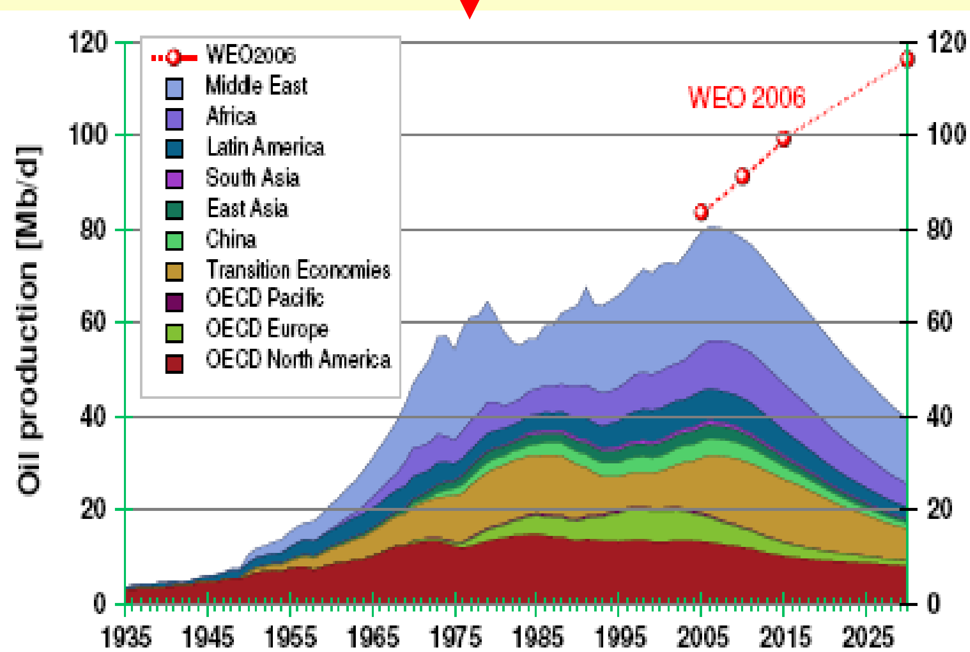
Colorado Springs
February 3-4, 2009

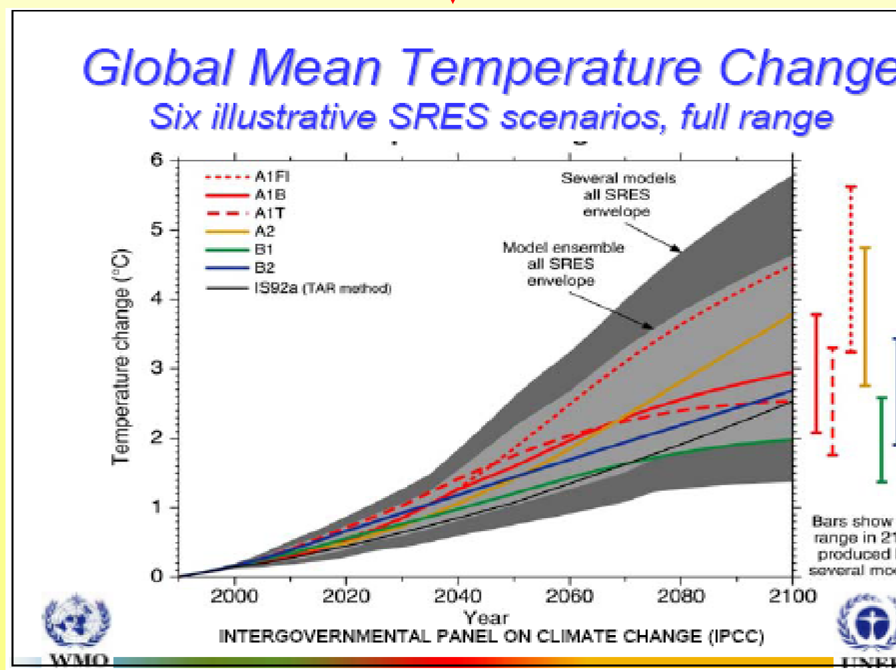
„Energy Efficient Community Systems“

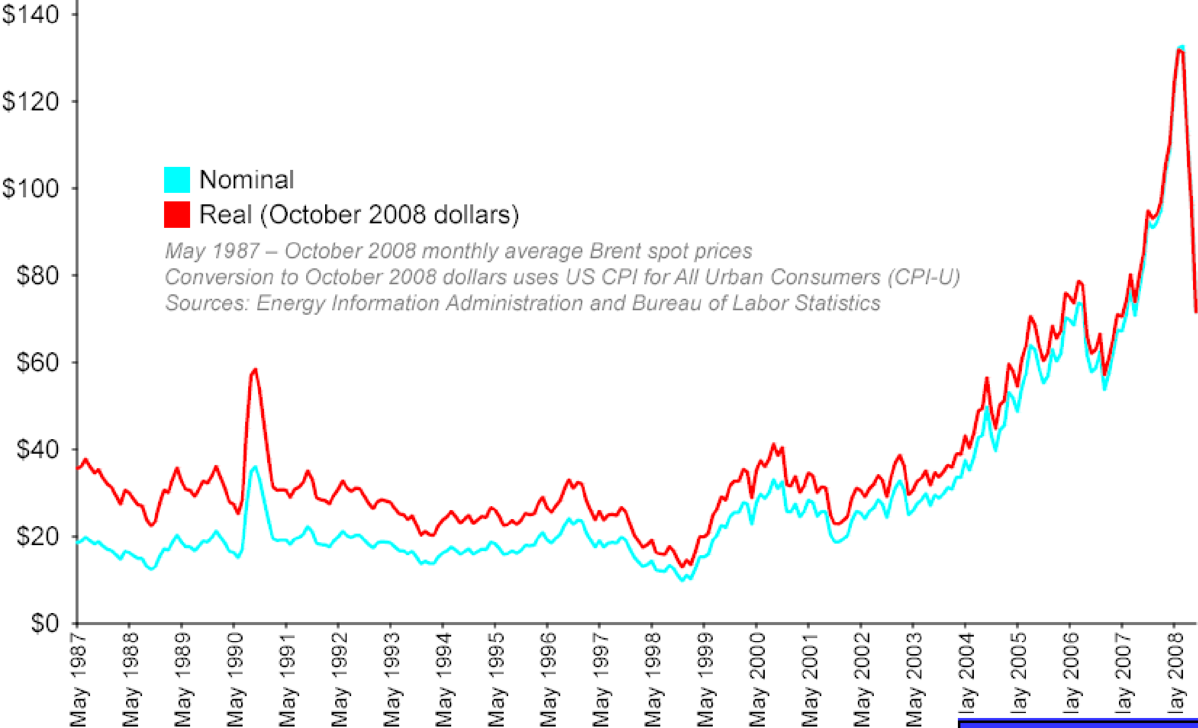
R. Jank, Karlsruhe, Germany


Global Primary Energy
Primary Energy (EJ)
450
400
350
300
250
200
150
100
50
0
1850
1900
1950
2000
Renewable
Nuclear
Microchip
Commercial aviation
Nuclear energy
Gas
Oil
Television
Vacuum tube
Gasoline engine
Electric motor
Steam engine
Coal
Biomass
Nakicenovic
#7
2006

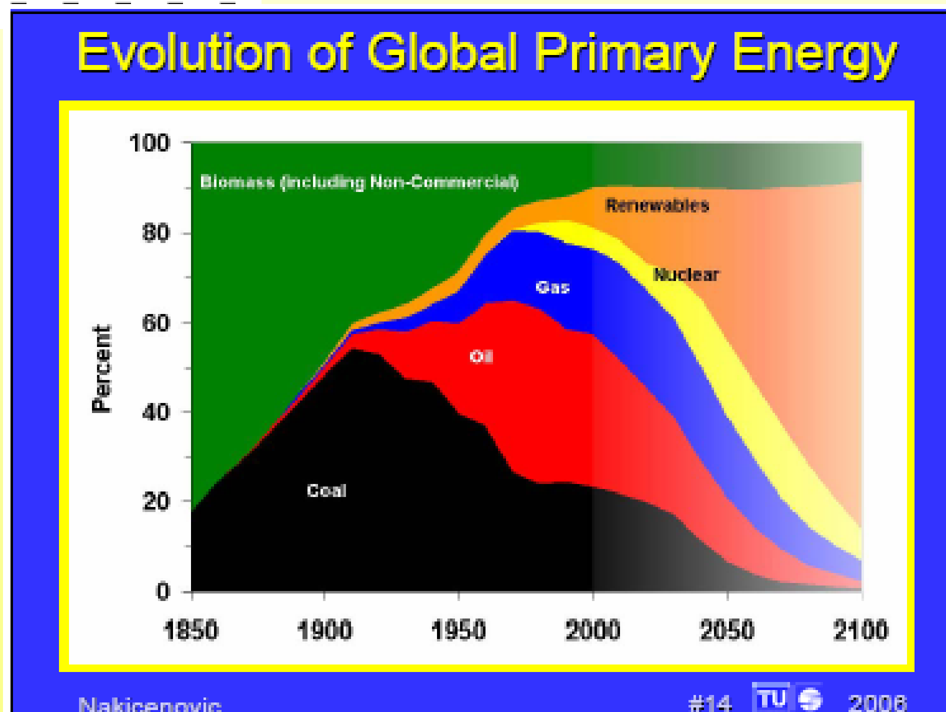

MAUNA LOA OBSERVATORY, HAWAII
MONTHLY AVERAGE CARBON DIOXIDE CONCENTRATION
MLO-144
CO2 CONCENTRATION (PPM)
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310
1958 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04
YEAR
Now
C=385
Was
C_0 = 280


Oil production [Mb/d]
120
100
80
60
40
20
0
WEO2006
Middle East
Africa
Latin America
South Asia
East Asia
China
Transition Economies
OECD Pacific
OECD Europe
OECD North America
WEO 2006
1935 1945 1955 1965 1975 1985 1995 2005 2015 2025


Global Mean Temperature Change
Six illustrative SRES scenarios, full range
Temperature change (°C)
6
5
4
3
2
1
0
A1FI
A1B
A1T
A2
B1
B2
IS92a (TAR method)
Several models all SRES envelope
Model ensemble all SRES envelope
2000
2020
2040
2060
2080
2100
Year
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)
WMO
UNEP

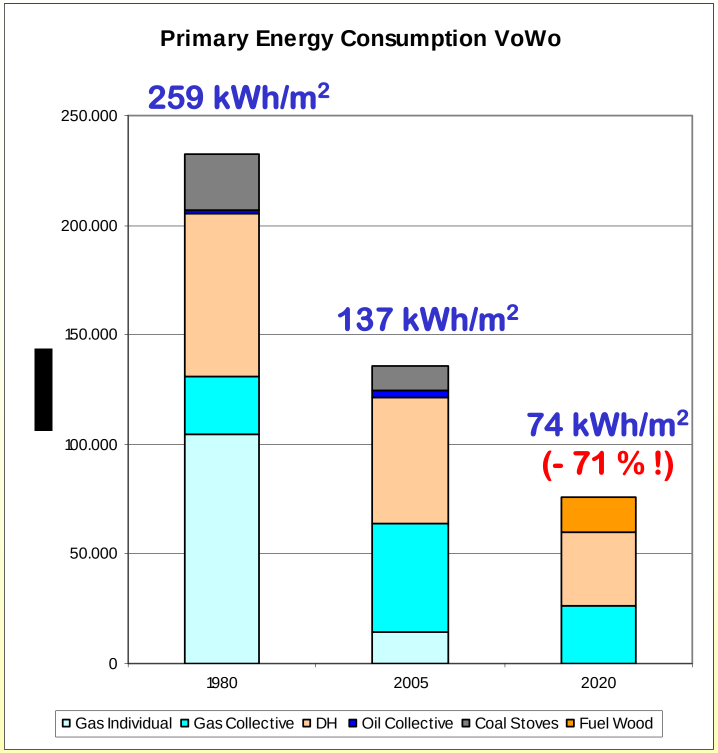


- ► **The magnitude of change required is huge**
- ► **A paradigm shift is needed:**
  - **energy end use efficiency**
  - **renewables**
  - **new nuclear**
  - **carbon capture (?)**



Karlsruhe, Baden-Württemberg, Germany

Volkswohnung's Retrofit Program over 35 Years:



Volkswohnung: 14.000 dwellings, 460 buildings
retrofit program: 25 Mio. €/a

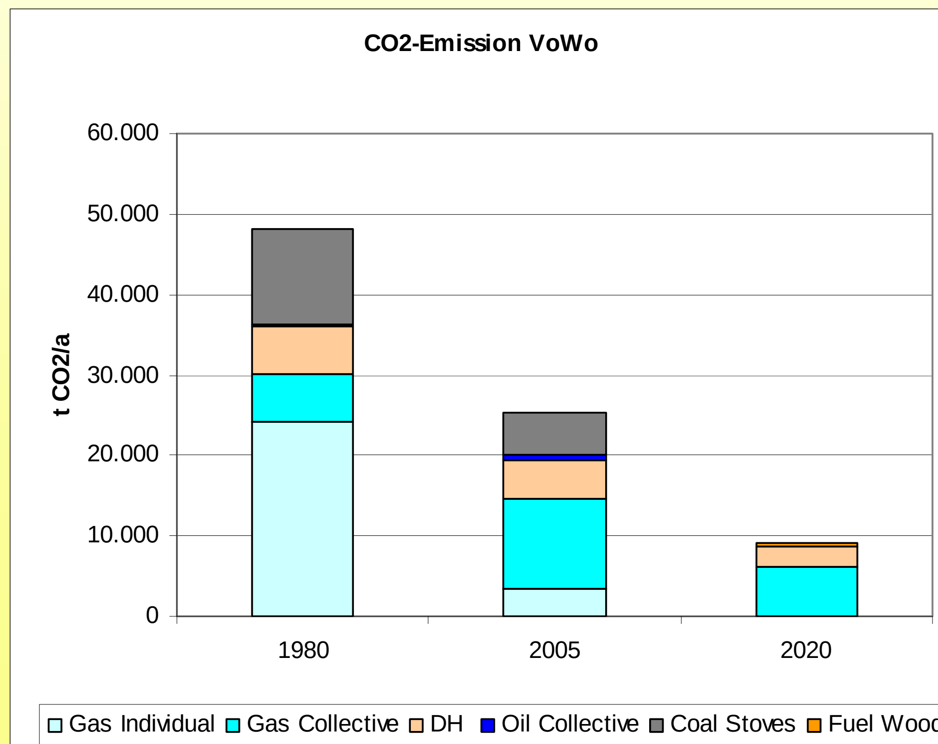
→ City of Karlsruhe:

~ 12 % of heating demand

~ 3 – 4 % of PE consumption

… big step for Volkswohnung,

small step for the city …



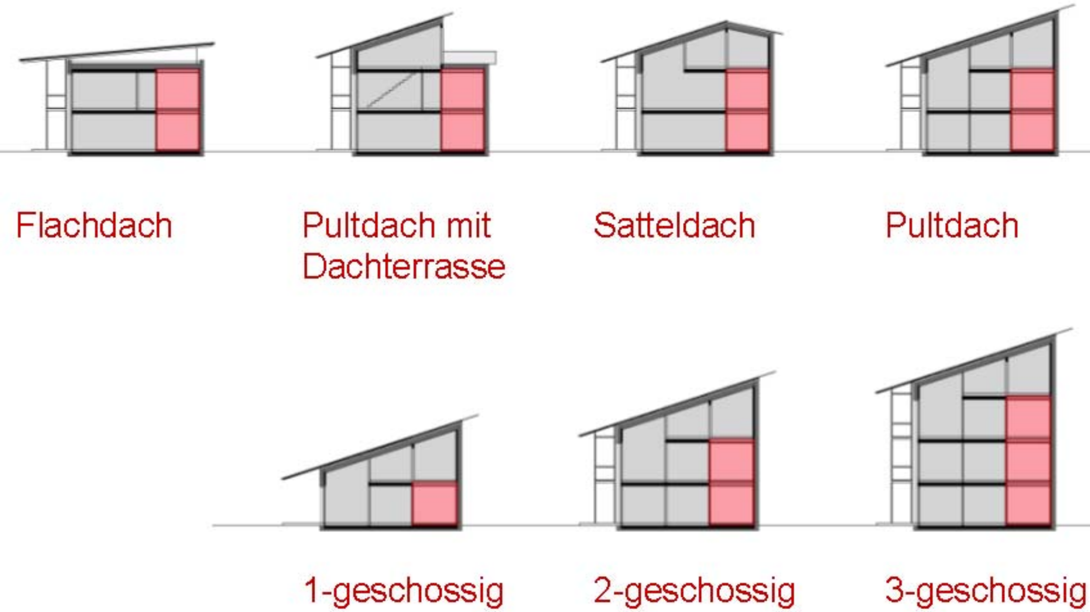
„Zero Energy Building“
Weber-Haus, Karlsruhe

Plusenergiehaus®

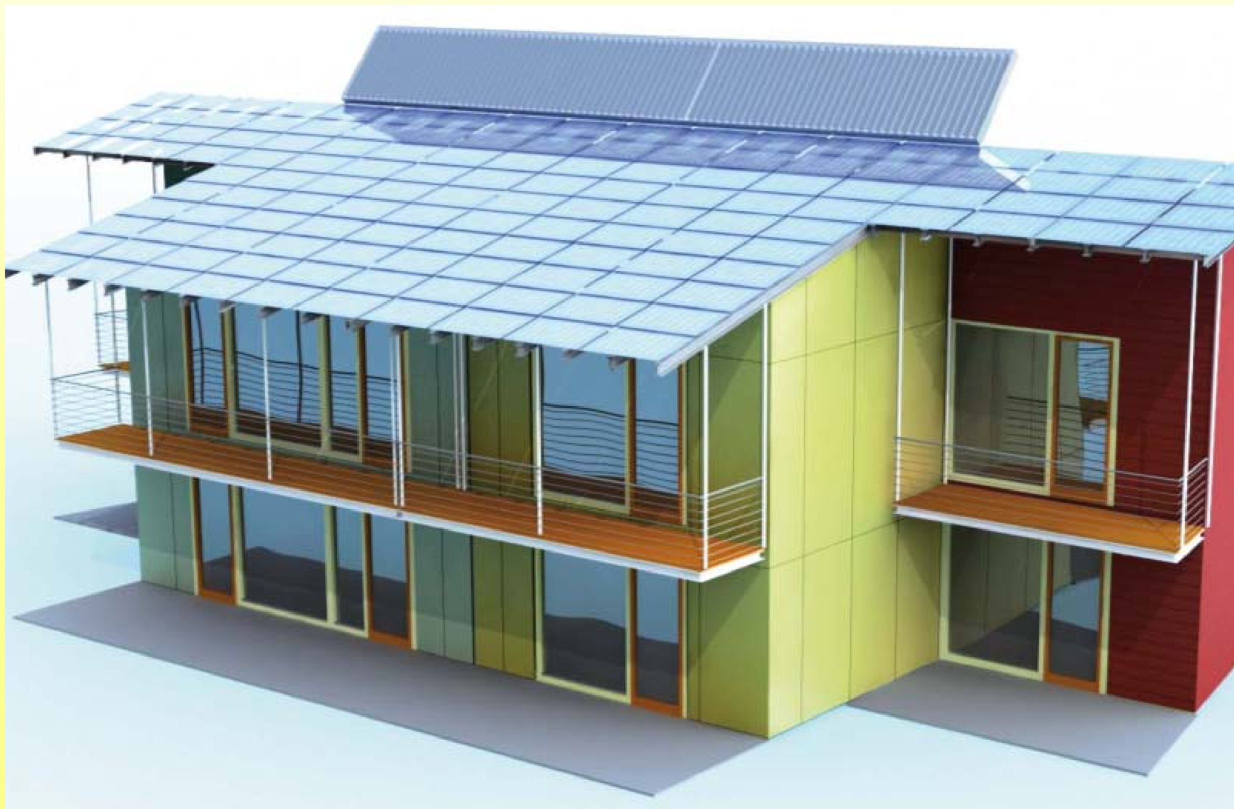
Rolf Disch, Architect, Freiburg

„Solar neighborhood“, Schlierberg/Freiburg

→ 50 „Plus-energy“ single-family buildings



R. Disch:
NZE construction modules:
pre-fabricated
single family row hauses
(2-days construction time)



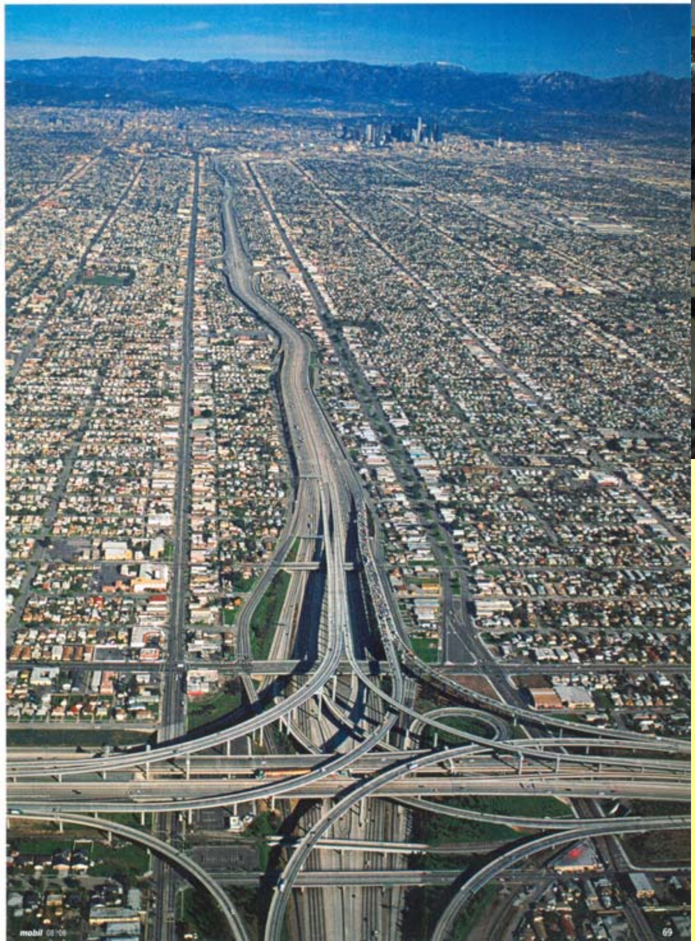
Passivhaus – approach: a general strategy?

Construction rate of new buildings in Germany: < 0,7 %

(demolition rate still smaller)

→ existing building stock is the problem!

„Building stock“??



→ Refurbishment of existing building stock

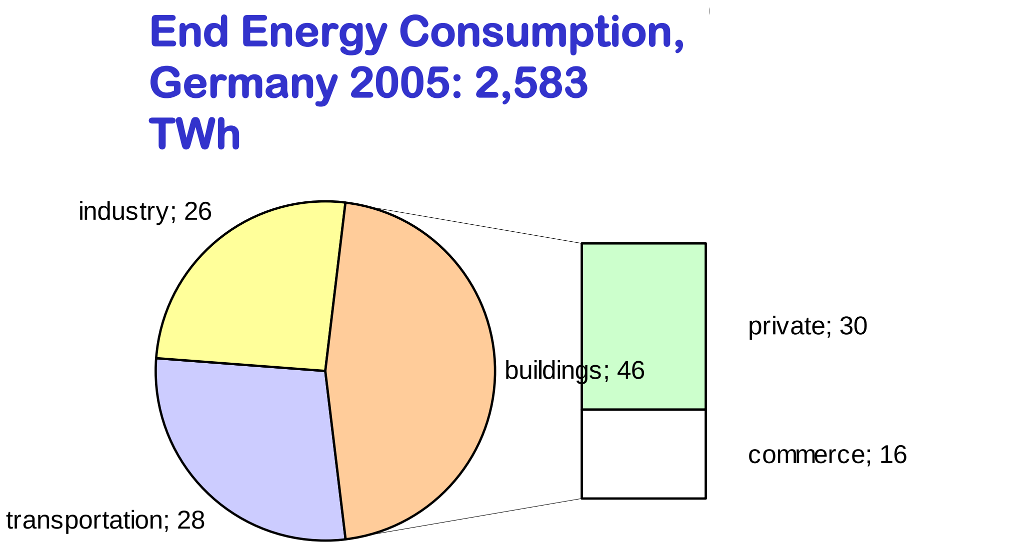
~ 30 billion € per year in Germany → cost-efficiency?

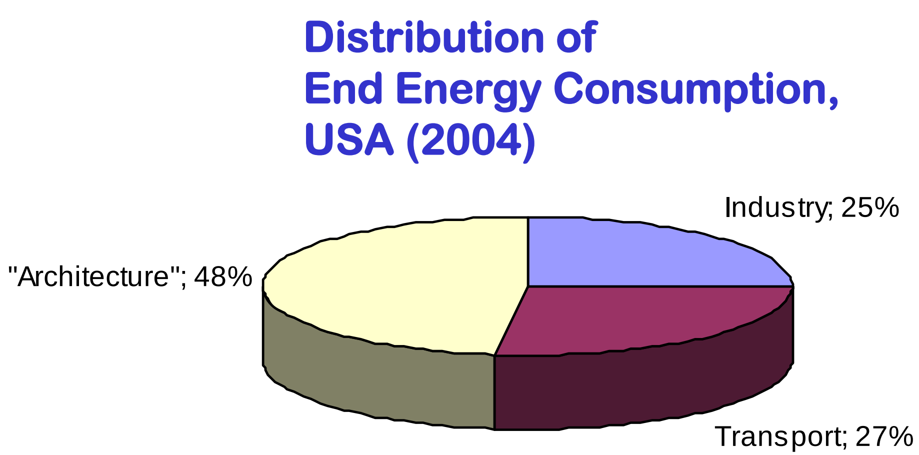
→ more energy efficiency options available: - **DH / CHP or cogeneration**
- LowEx-technologies (waste heat, heat pumps)
- **renewables**

„Economy of scale“ → many buildings → **„community-wide“ approach necessary!**

Potential results:

- more cost-effective
- available with established technologies
- higher implementation rate
- 60 – 80 % targets available (fossil energy consumption, CO_2-emission)





Conclusion:

cities / towns / communities are key to success in climate change policy

Community programs at national level:

The Netherlands:

Long-term research program established (EOS-LT)
Part of it: TRANSEP

"Transition in Energy and Process for Sustainable Community Development"
Research group: Universities, Planners, Developers, Communities

Germany:

2 national support programs since 2008:
→ urban quarters (focus is on innovative technology implementation)
→ whole towns / cities (focus on „holistic" approach)
volume: > 100 mill. €, > 5 years (including investments)

Canada:

- support of sustainability projects on community level
- evaluation of projects, planning guidelines (LowEx-principles, data collection, benchmarking, monitoring)

France:

„eco-quartier" program (launched late 2008)
(part of new French climate change policy)

Japan:

- national program on climate change → focus on distributed energy supply and emergency precaution

International Co-operation in the frame of IEA:

Annex 51 - Energy Efficient Communities

Lead: France
(EiFER)

Subtask A:
State-of-the-Art

Lead: Sweden
(Prof. Moshfegh)

Subtask B:
Case studies
(community areas)

Lead: The Netherlands
(Prof. Kimman)

Subtask C:
Case studies
(towns/cities)

Subtask D:
- Guidebook
- C-ECA
- Dissemination

Lead: Germany
(H. Erhorn)

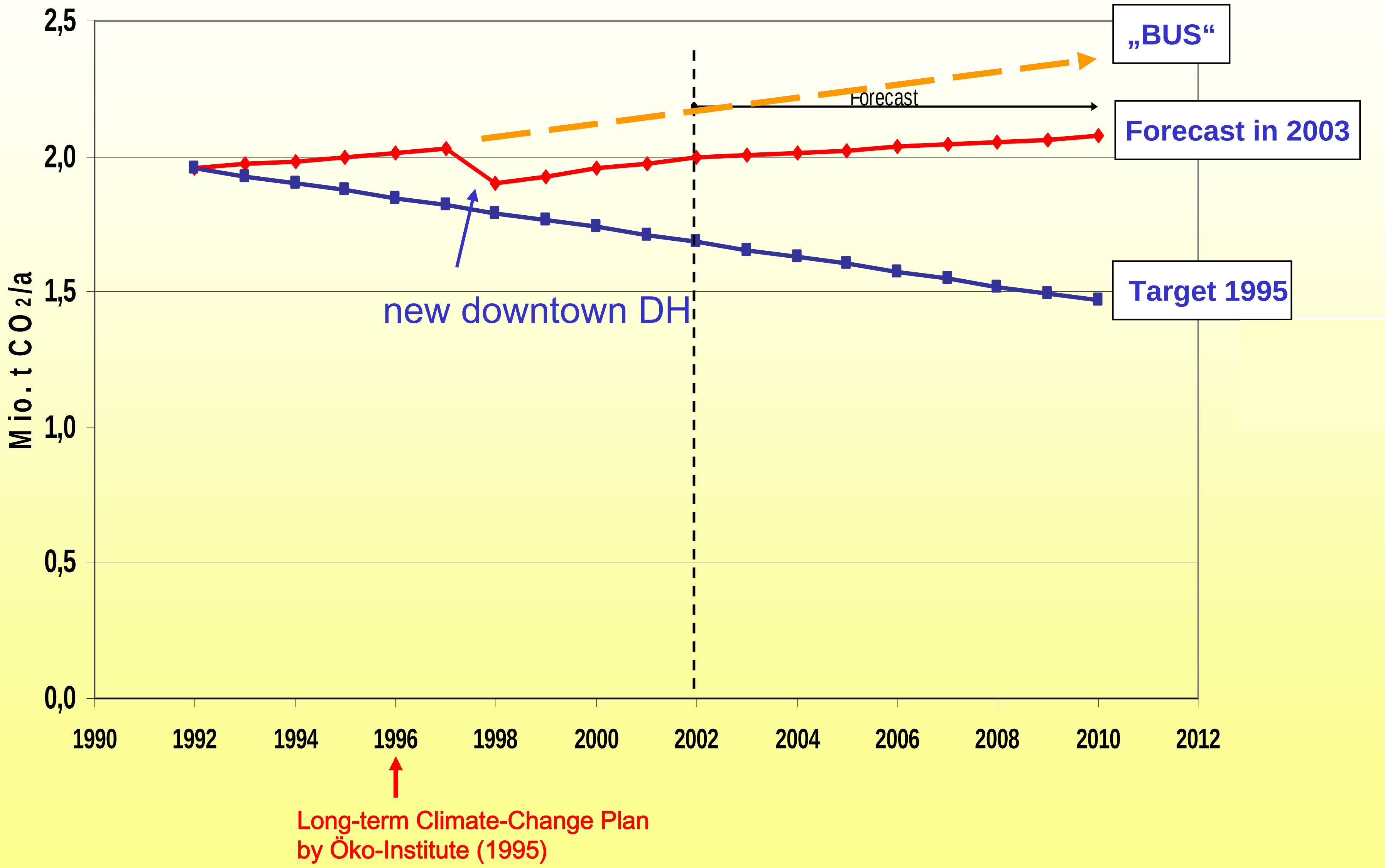
Operating Agent: R. Jank

Participants:

Canada
Finland
France
Denmark
Germany
Japan
The Netherlands
Sweden

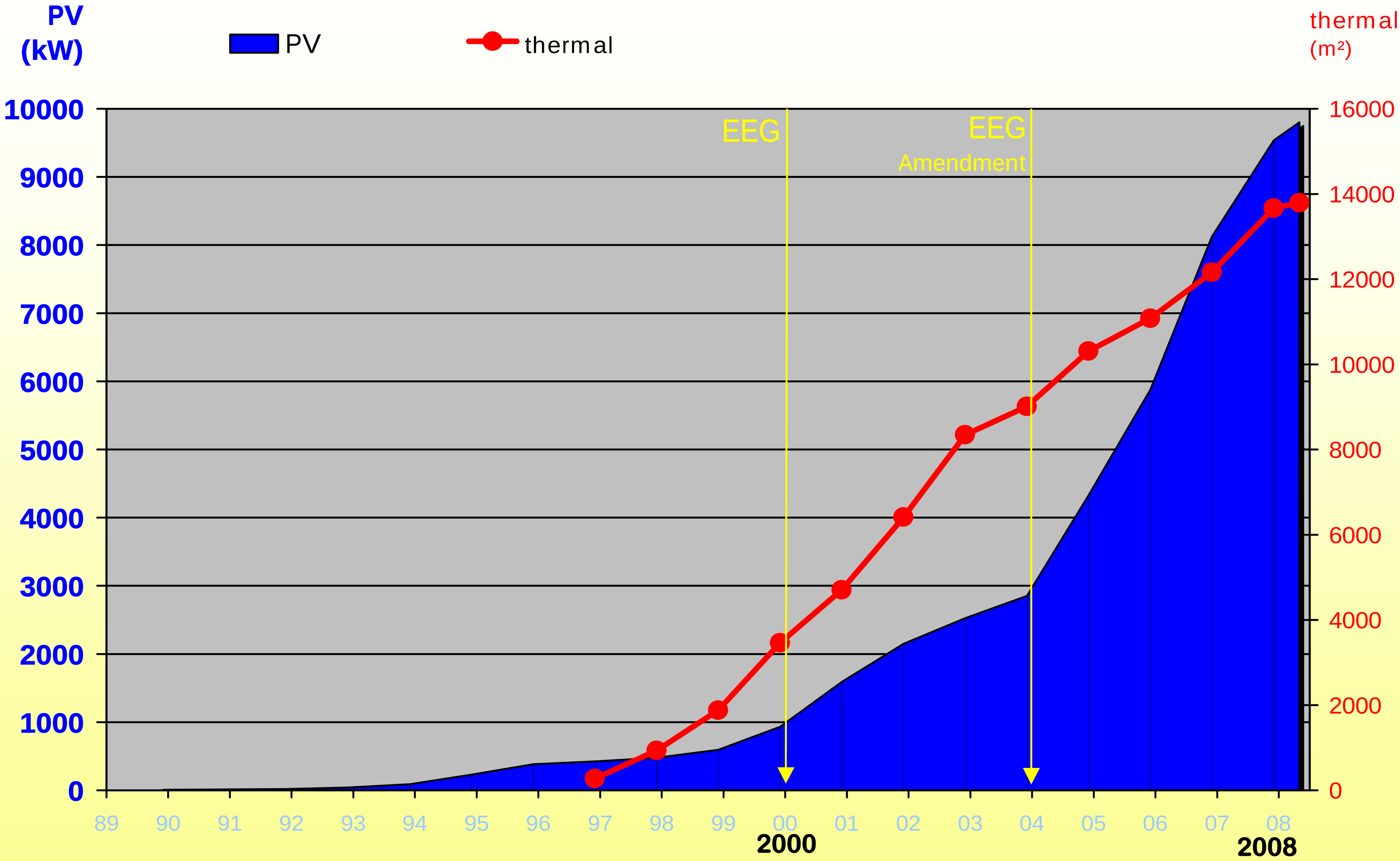
Example: Climate Change Plan Freiburg 1995

wish and reality



Freiburg, the
„Solar Capital“
of Germany

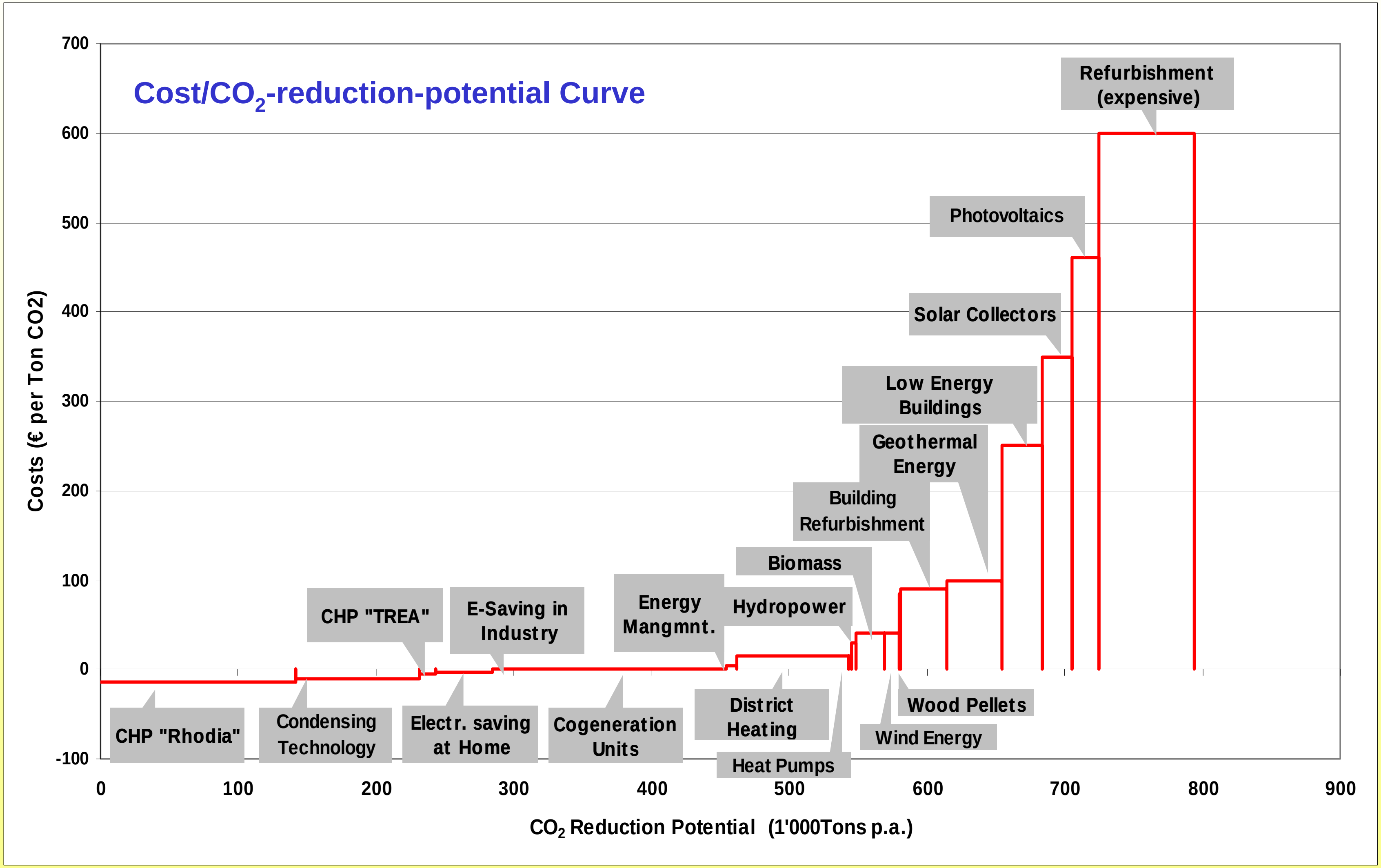
Solar installations in Freiburg



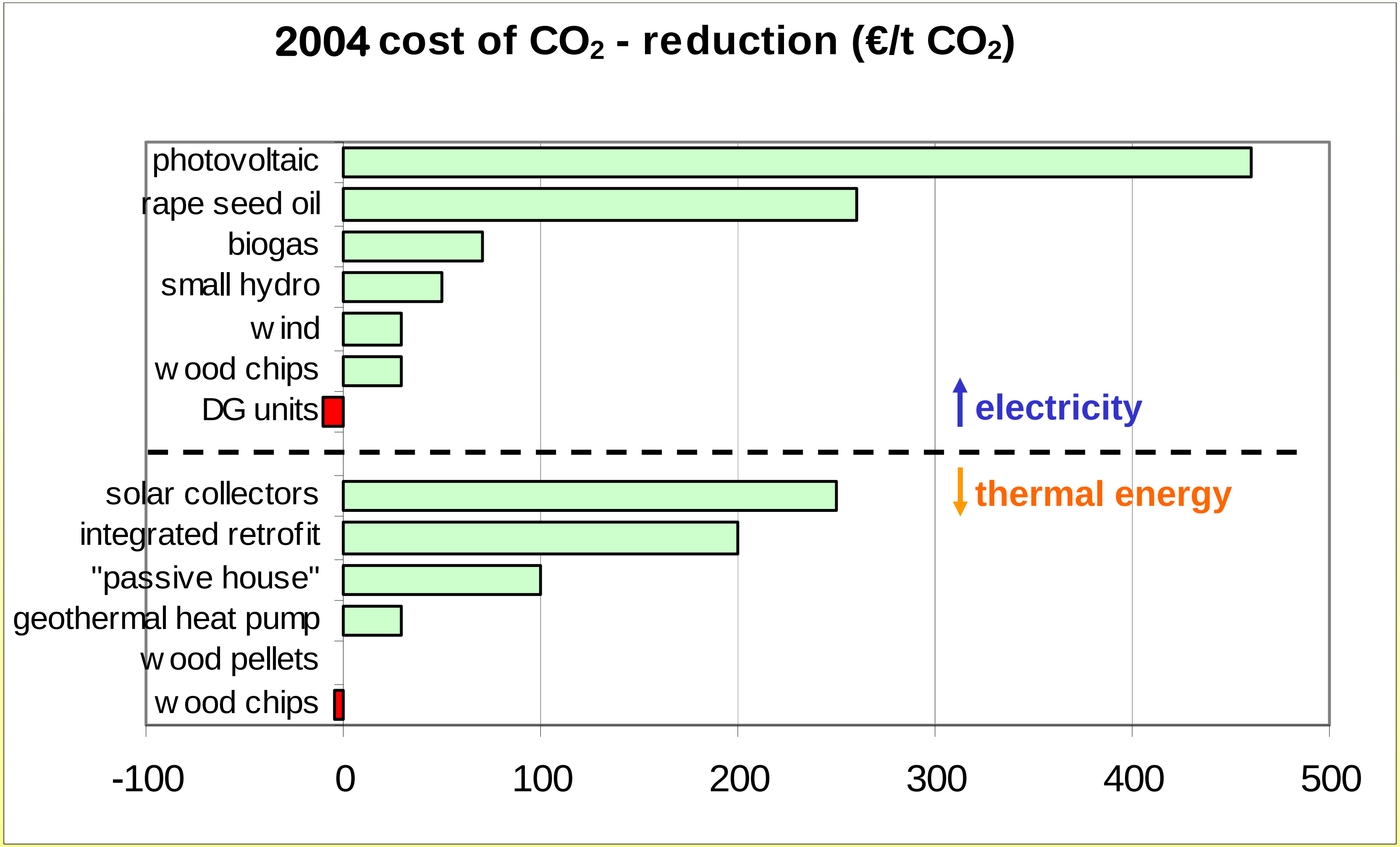
Electricity demand in FR: ~ 200 MW_{el}

→ PV-Capacity: ~ 2.5%

Freiburg 2004 (200.000 inhabitants)



For a local energy efficiency strategy,
cost-structures and local potentials are essential!



But: figures depend from the energy prices assumed !
(and many other variables)

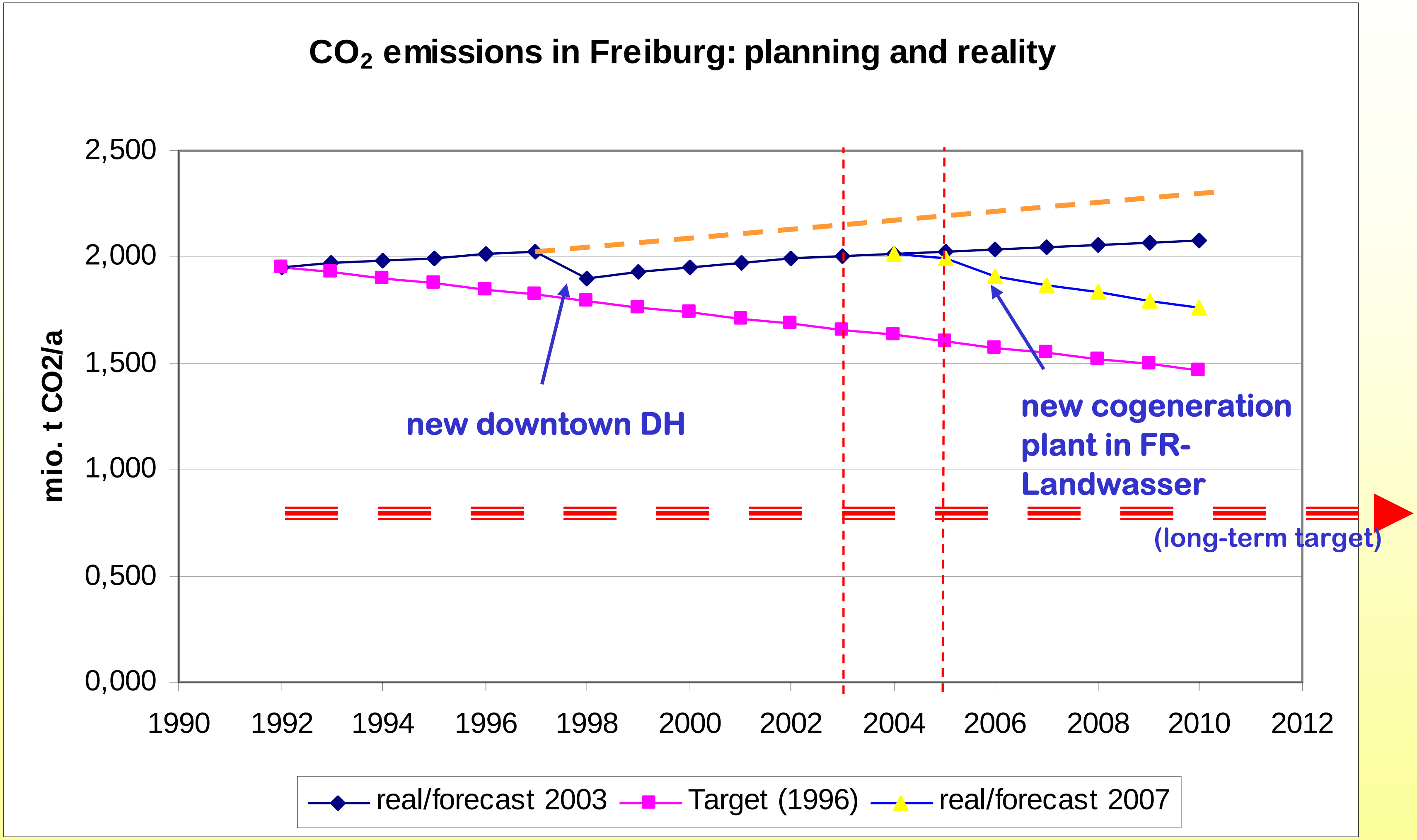
Adjusted energy policy in Freiburg (2005):

Focus on

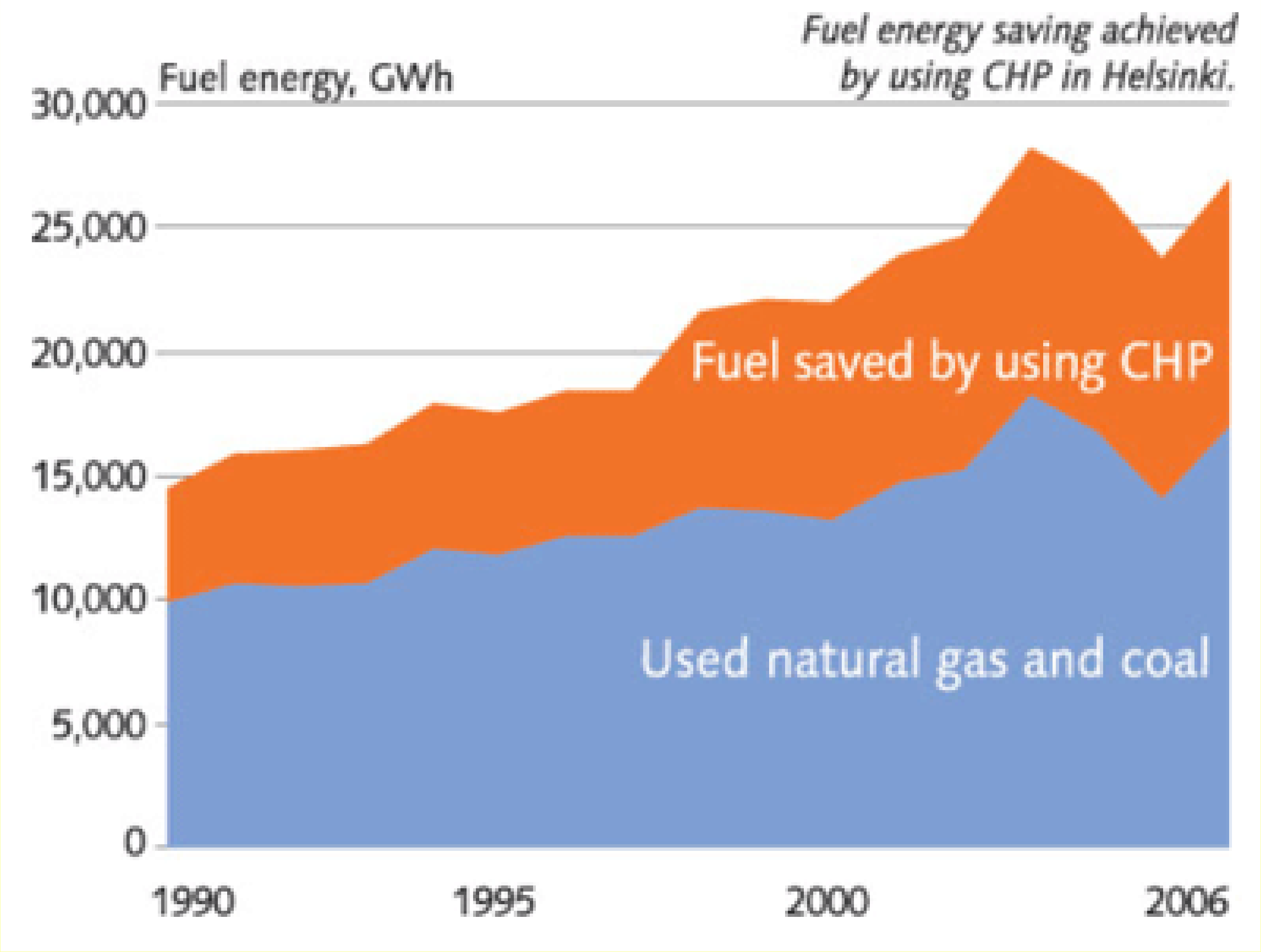
- energy conservation in buildings
- co-operation with local utility to increase cogeneration projects
- urban transportation policy
- GHG/energy inventory every 2 years
- feed-back: updated action plan
- stimulus budget of 1.2 mio. €/a for urban climate change action projects

2005: new cogeneration power plant in Freiburg-Landwasser
3 000 kW_{el}
12 000 kW_{th} (incl. PL)


March
Gundelfingen
Landwasser
Wärmeverbund-
Kraftwerk
Zähringen
Rieselfeld
Betzenhsn.
Universität
Herdern
FRE
Weingarten
Haslach
Wiehre
St. Georgen
Litte
Vauban
Günterstal
Merzhausen


CO2 emissions in Freiburg: planning and reality
mio. t CO2/a
2,500
2,000
1,500
1,000
0,500
0,000
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
new downtown DH
new cogeneration plant in FR-Landwasser
(long-term target)
real/forecast 2003
Target (1996)
real/forecast 2007

Helsinki 2006: > 80 % CHP DH



Quelle: Helsinginenergia (2007)
www.C40cities.org

Energy Efficient Communities

Targets:

- reduce energy demand

- improve efficiency

- increase use of renewables

→ **Tasks:**

➢ **improve buildings efficiency**

- refurbishment
- standards for new buildings
- optimization of technical equipment

➢ **install decentralized energy supply**

- cogeneration
- waste heat
- renewables

➢ **drive behavioral changes**

➢ **improve transport efficiency by**

- using efficient cars
- change from car to bike / walk
- extend public transportation

Steps towards an energy efficient community:

(1) Community **energy/CO_2-balance**, BAU scenario, long-term targets

(2) Portfolio of **conservation/renewable measures** locally available

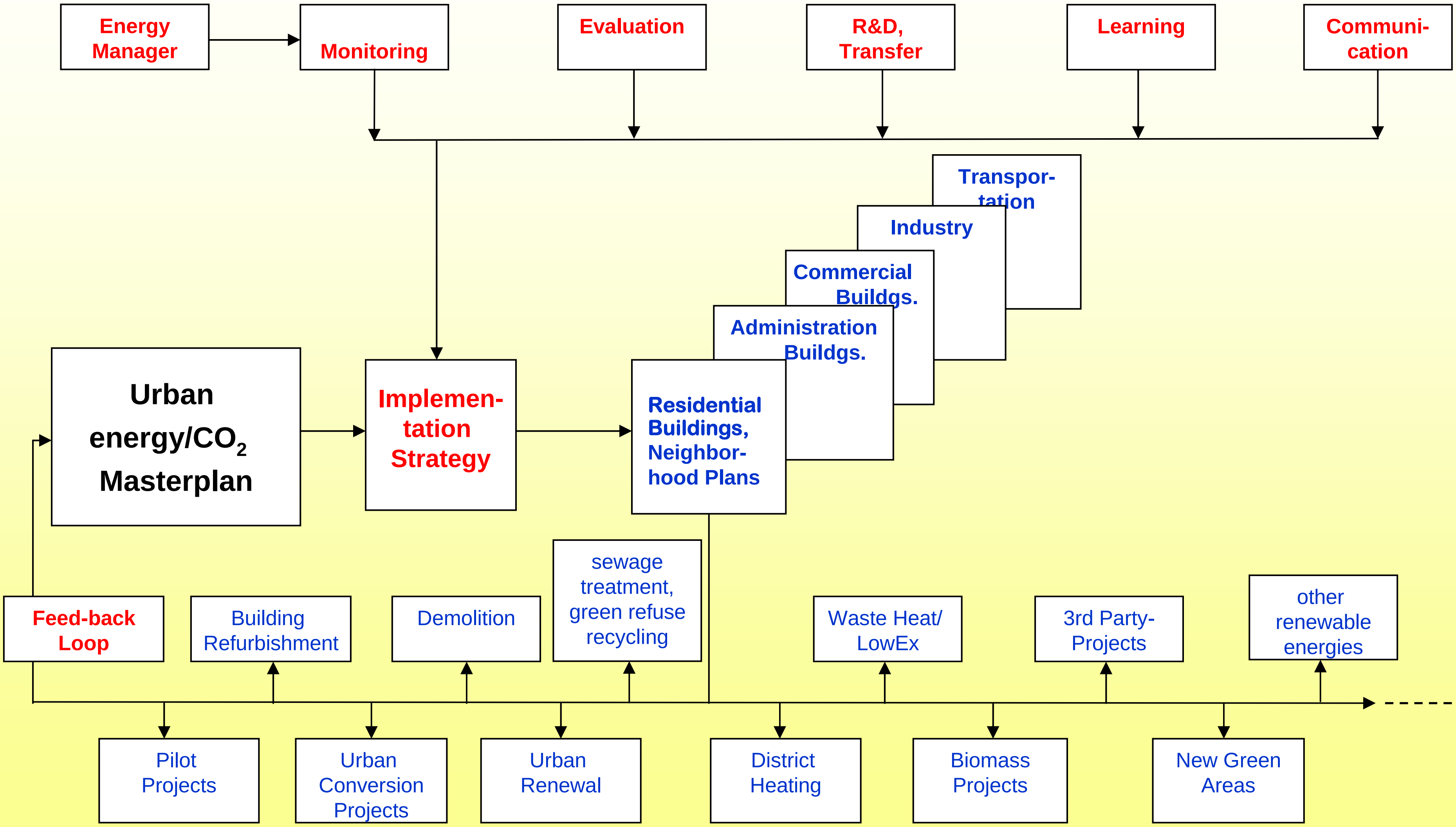
- cost
- potentials

(3) System integration: long-term **masterplan** (→ *energy system model?*)

(4) **Implementation strategy**: projects, financing, organization ….

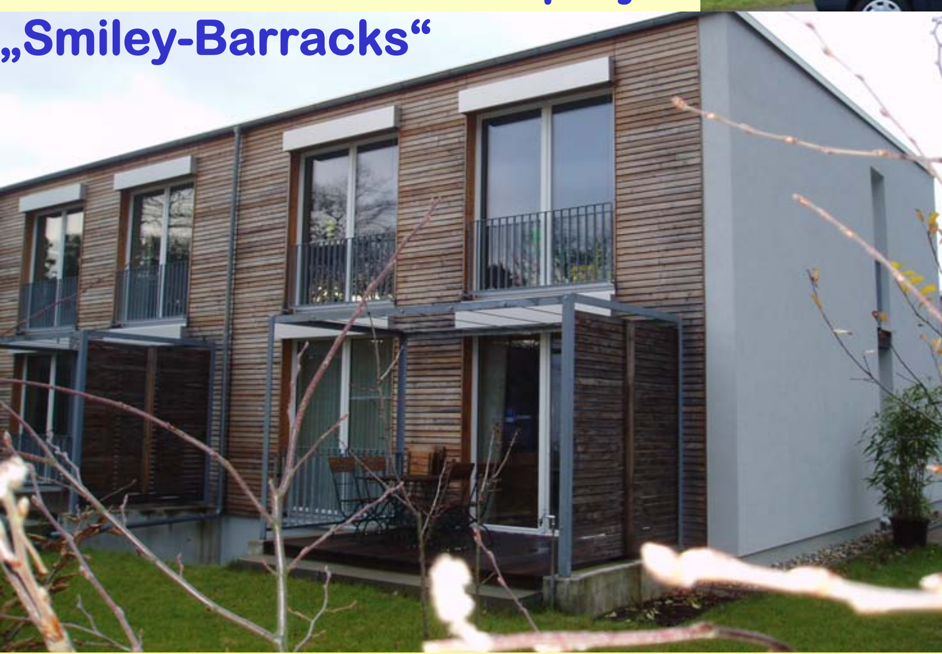
(5) Monitoring / evaluation / feed-back / **adjustments**

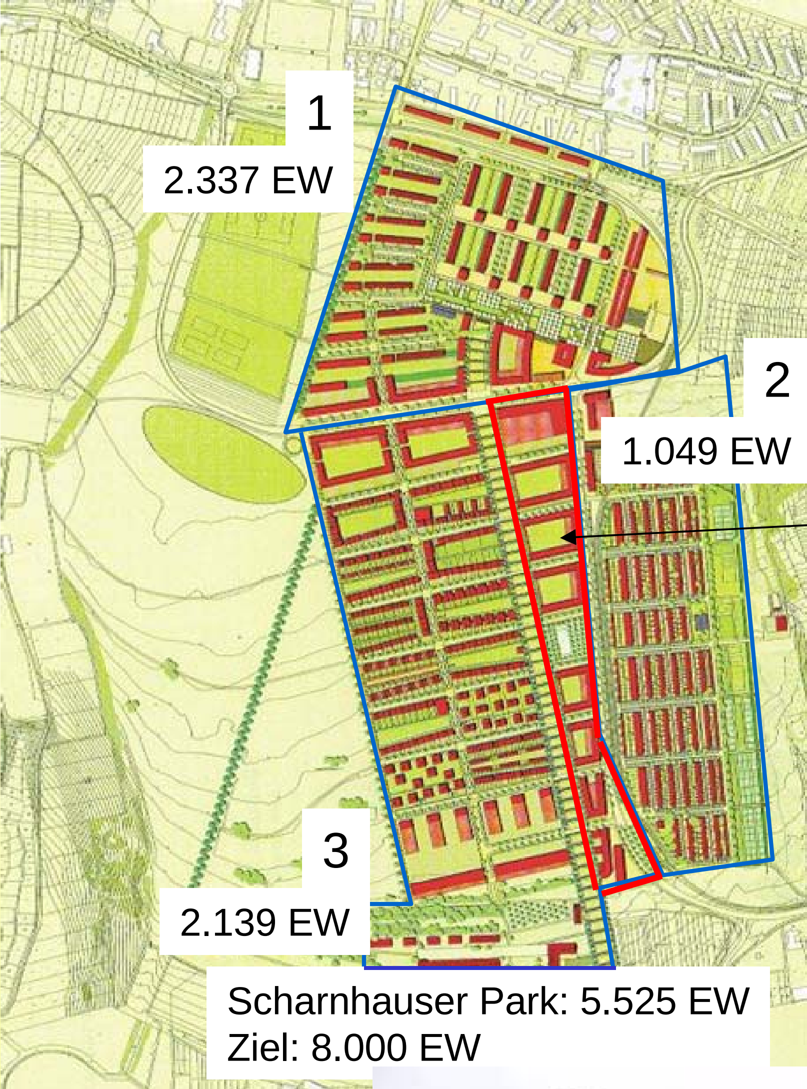
… from planning to realization: a continuous process …



Smaller scale examples in the context of „NZE-Installations“

Karlsruhe: Conversion-project „Smiley-Barracks“





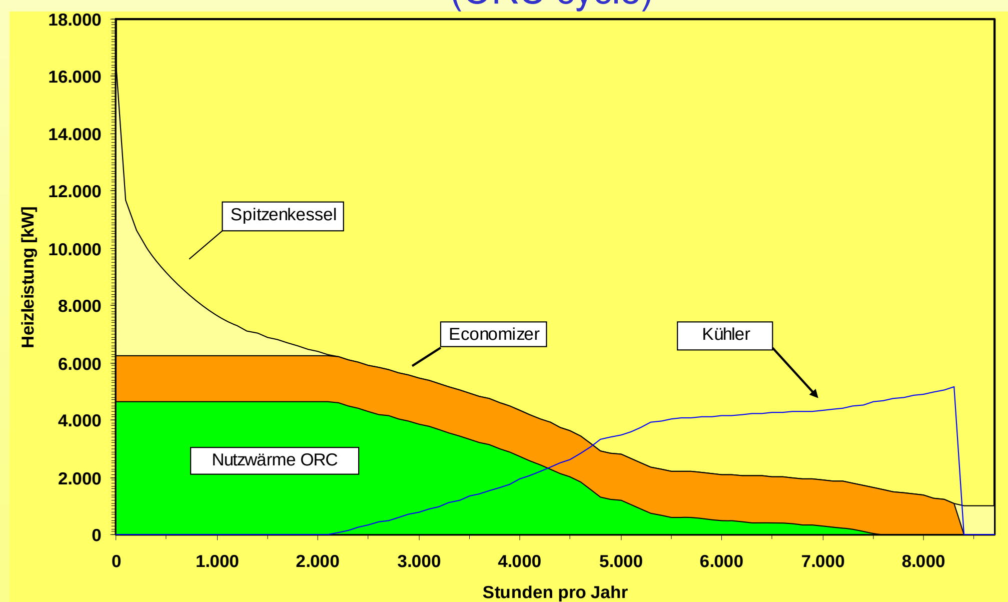
„Eco-Neighborhood Scharnhauser Park“

(formerly „*Nellingen Barracks*“ of US Army)

Operator:
Stadtwerke Esslingen

Commercial area
200 kW_{th}
100 $kW_{cooling}$

Wood chip boiler: 8.0 MW_{th}
heat supply: 5.3 MW_{th}
el. power: 1.0 MW_{el}
(ORC cycle)



Example Mauenheim Village: Energy contracting company ***„Solarcomplex“***

New biomass energy supply system Mauenheim (Lake Constance)

Result:
~ 2.2 Mio. € investment
~ 400 000 €/a energy costs „kept home“

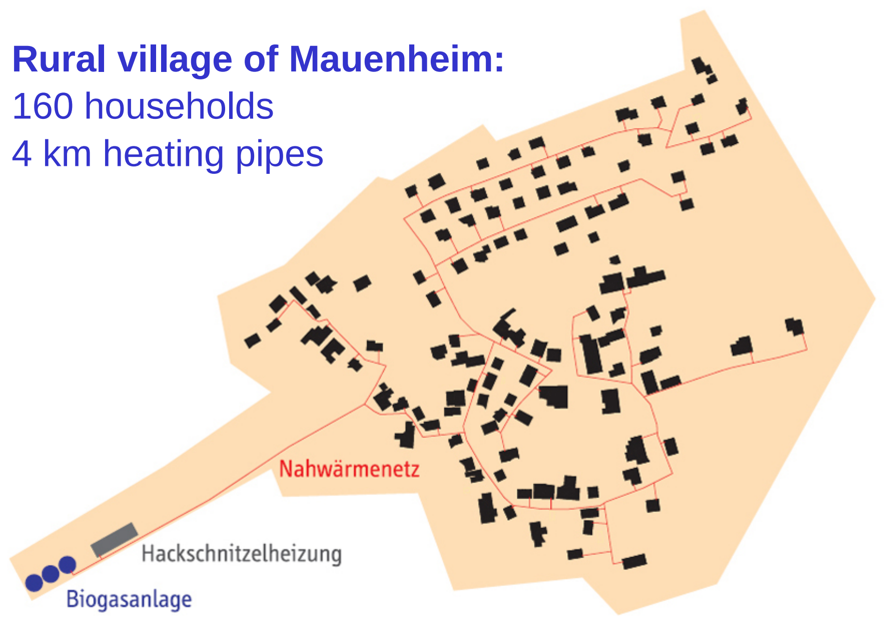
biogas plant:
260 kWth
250 kWel
(manure, grass, corn, agricultural refuse)

wood chip heating plant:
600 kWth

PV array:
150 kWel

wood chip store

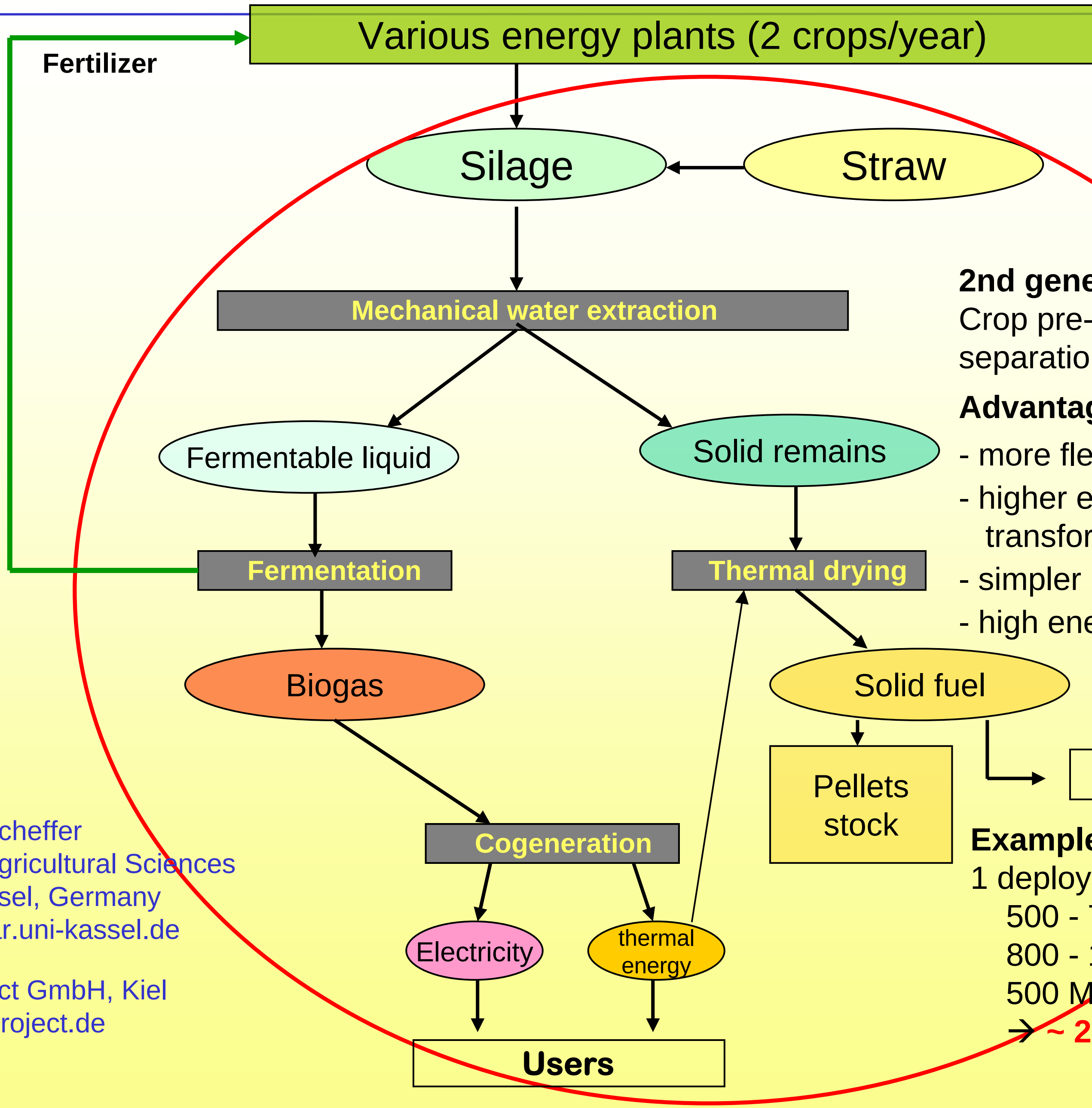
Rural village of Mauenheim:
160 households
4 km heating pipes



Solarcomplex:

- **600 local shareholders**
- **50 installations operated since 2004**

2nd generation biogas plant: (Univ. Kassel)



2nd generation biogas plant:
Crop pre-processing and separation

Advantages:

- more flexibility (plant input, size)
- higher efficiency (70 % of plants transformed in usable energy)
- simpler process stages
- high energy gain: ~ 8 t oil equ./ha

Example:
1 deployed installation:
500 - 700 kW heat load
800 - 1 200 MWhth/a
500 MWhel/a (~ 70 kWel)
→ **~ 20 ha**

Source:
Prof. K. Scheffer
Inst. for Agricultural Sciences
Univ. Kassel, Germany
www.agrar.uni-kassel.de

GETproject GmbH, Kiel
www.getproject.de

(Former) US Intelligence Facility Bad Aibling:
Conversion to NZE Community

Conclusions:

(1) **Energy / GHG targets in communities already achievable with todays technologies** (impovements are welcome)

(2) **There is no general solution**

→ site-specific planning and optimization necessary

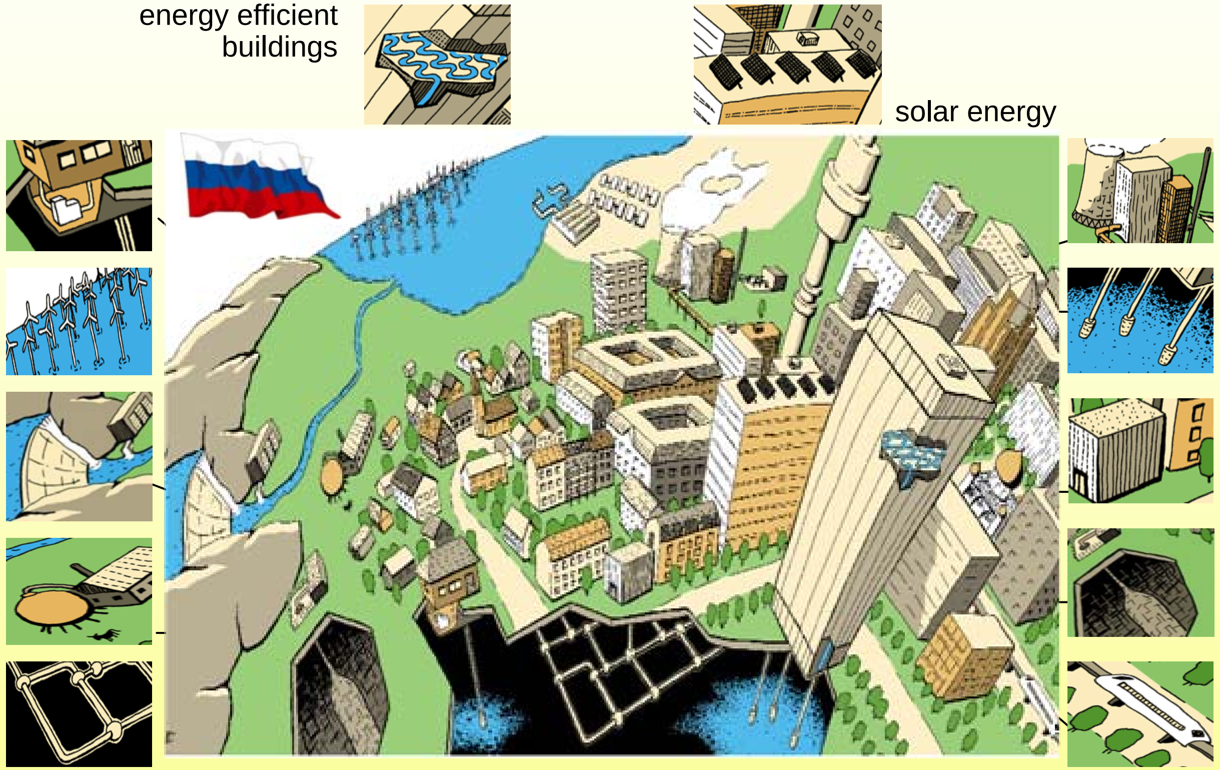
- systems approach:
  whole chain from demand to supply must be considered:
  buildings → neighborhoods → energy infrastructure (→ surrounding areas)

- **long-term planning (LCA)** instead of first-cost minimization

- many people involved, high project complexity

„energy-efficient city“ …

... is attained by a combination of selected technologies that can be used in the specific local context to achieve the required level of energy consumption.



economic efficiency by integrated system optimization

Source: EnBW AG, Karlsruhe

R&D key thrusts to achieve „NZE“:

Demand:

- walls and roofs
  (including coupling to the environment)
- pre-fabrication
- smart buildings
- battery-less sensors/actuators
- LowEx buildings
- lightning, el. appliances

Supply:
decentralized forms of el. / heat supply

- medium sized cogen. plants (1 – 10 MW)
- industrial waste heat utilization
- wood chip plants with el. generation
- wind parks (10 – 100 MW_{el})
- solar-thermal power plants (10 – 20 MW_{el})
- bioenergy plants (10^2 – 10^3 kW_{el})
  (biogas, 2nd-generation biofuels)
- small/micro cogeneration
  (10^1 – 10^3 kW_{el} scale)
- small scale wind generators (~ 1 MWel)
- wood pellet boilers
  (10^1 – 10^3 kWel scale)
- ground-coupled heat pumps
- solar heating / cooling
- PV

Cogeneration manufacturers:

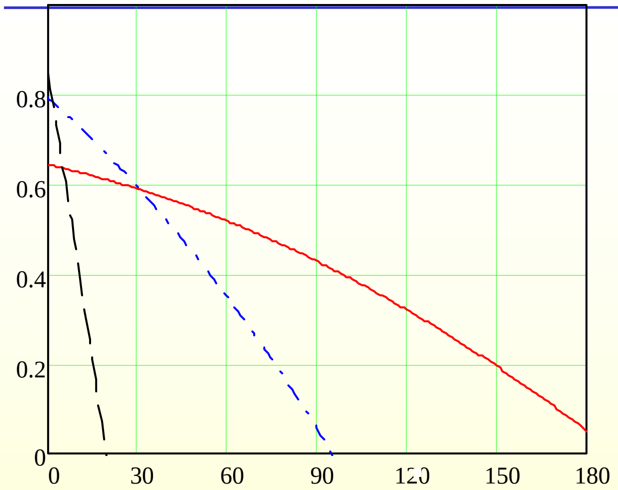
0.5 – 2 MWel: Caterpillar, Waukesha (US)
Wärtsilä (SF), KHD (D) …

50 – 300 kWel: MAN, Communa, …

5 – 50 kWel: Fichtel&Sachs, Volkswagen, …

… technology available, market deployment gap

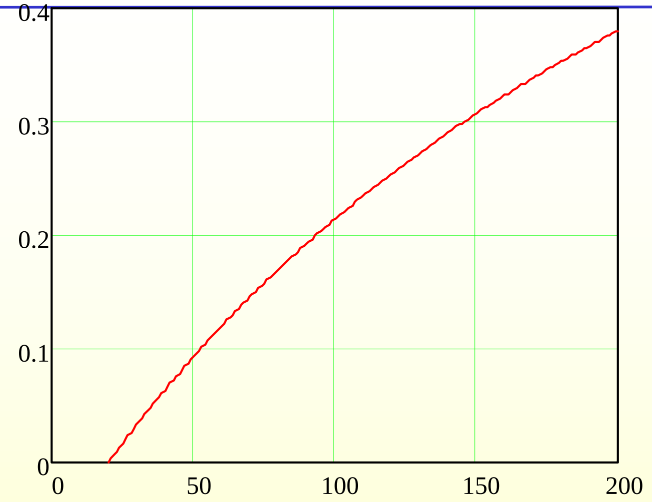
Solar collector efficiency



Delta T (°C)

- tube collector
- flat plate coll.
- solar absorber

Carnot-Factor



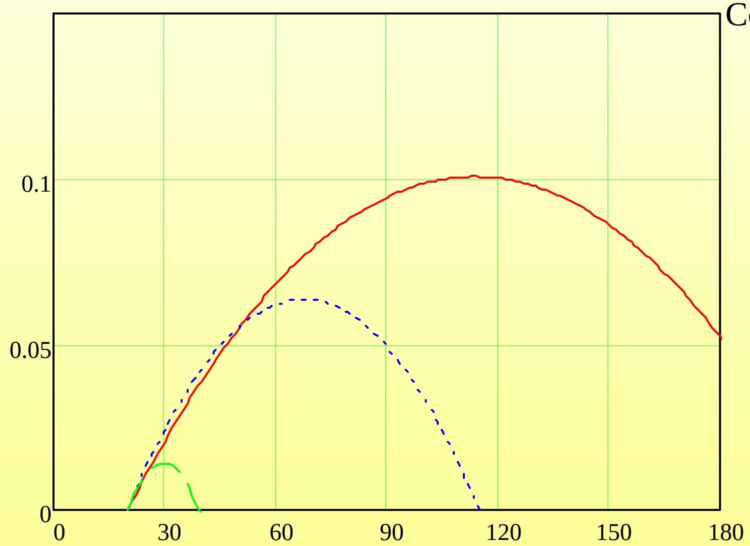
Collector mean temperature (°C)

$$\eta_C = \frac{\Delta T}{T + 273.15}$$

$$E(Q) = Q \cdot \eta_C$$

$\downarrow$

Exergetic Performance



collector mean working temperature (°C)

- tube collector
- flat plate coll.
- solar absorber

Application: solar cooling

- **Barriers**
  - inertia
    - technological lock-in
    - ignorance
    - insufficient capacity (analysis/design/decision)
  - upfront investment costs
  - economic
    - market failures:
      - insufficient information
      - split incentives (landlord/tenant problem)
      - transaction cost
      - intangible cost not incorporated
    - non-market failures:
      - technical risk
      - technology not fully commercialized (pilot/demo phase)